Introduction to Special Issue on Application of Concurrency to System Design (ACSD'13)

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Concurrent computing systems have been investigated since the early 1960s. Many formal methods were introduced for their specification and verification, such as Petri nets, process algebras (e.g., CCS and CSP), and VDM++. These formal models were employed in many application areas where concurrency played an important role, including electronic circuits, real-time systems, embedded systems, mobile and wireless networks, cyber-physical systems, and business processes. With the emergence of new hardware architectures and new programming paradigms, as well as new developments in the game industry and Internet and medical applications, new challenges arise related to concurrency aspects of software and hardware systems.

The *International Conference on the Application of Concurrency to System Design (ACSD)* serves as a forum for disseminating theoretical results with application potential and advanced methods and tools for the design of complex concurrent systems. The main aim of the ACSD conferences is to bring theoreticians and practitioners closer together in order to ensure that the academic community is informed about recent industrial challenges and that industry-based researchers are up to date with new theoretical developments. The 13th conference in this series was held in July 2013 in Barcelona, Spain. To further publicize the results of this meeting and to encourage more researchers to join the community working on applications of concurrency to system design, the conference was followed by an open call for papers for a special issue of the ACM TECS journal. The call was open to all conference papers (provided that they were significantly extended) as well as to any original theoretical and application contributions on topics relevant to the ACSD conference series. All submissions were independently reviewed in terms of their scientific value and novelty, clarity of presentation, and practical interest. Out of 24 submissions, four were selected for this special issue of ACM TECS, including two extended versions of ACSD'13 conference papers.

The four articles contained in this special issue are relevant to a range of areas where concurrency plays a significant role, including software engineering, software verification, mathematics of computing, and programming techniques.

The first article, "Polynomial Sufficient Conditions of Well-Behavedness and Home Markings in Subclasses of Weighted Petri Nets" by Thomas Hujsa, Jean-Marc Delosme and, Alix Munier-Kordon, tackles the problem of finding sufficient conditions for well-behavedness (liveness and boundedness) of weighted Join-Free and Choice-Free net systems. The authors demonstrate that the proposed conditions can be checked in polynomial time. The article extends the existing results obtained for the subclass of weighted T-systems. Furthermore, the article proposes a polynomial time algorithm for constructing live home markings for Fork Attribution net systems (the intersection of Join-Free and Choice-Free net systems). The results of the article can be applied in the area of embedded system design to build systems with steady behavior (i.e., systems which are both live and reversible). The conference version of this article received the best paper award at ACSD'13.

The next article, "Incremental Bisimulation Abstraction Refinement" by Lei Song, Lijun Zhang, Holger Hermanns and Jens Chr. Godskesen, is concerned with model checking of probabilistic concurrent systems. The discussion is focused on an abstraction refinement approach for verifying behavioural properties of probabilistic automata

(PA) expressed using the PCTL logic. The main idea is to incrementally compute a sequence of may- and must-quotient automata induced by depth-bounded bisimulation equivalences of increasing depth. The latter converge to the genuine PCTL equivalence, and, for finite-state systems, the verification procedure terminates after a finite number of refinement steps. The effectiveness of the developed sound and complete probabilistic model-checking technique is demonstrated on experimental results obtained using a prototype implementation.

The third article, "Algebra of Parameterised Graphs" by Andrey Mokhov and Victor Khomenko, describes a theory of parameterised graphs representing behaviours of concurrent systems. The authors present axioms for the proposed algebra of graphs and prove their soundness, minimality, and completeness. They also consider the sub-algebra of parameterised partial-order graphs where the arcs are interpreted as a causality relation. Such an interpretation allows for certain simplifications and gives rise to the algebra of transitive parameterised graphs. The algebras introduced in the article allow one to use algebraic expressions in order to specify concurrent system behaviours in a compositional way. The article shows how the new algebras can be used in hardware design, in particular, to specify and analyse phase encoders, processor microcontrollers, and NAND gates in CMOS technology.

The final article, "Sequentially Constructive Concurrency—A Conservative Extension of the Synchronous Model of Computation" by Reinhard von Hanxleden, Michael Mendler, Joaquin Aguado, Bjorn Duderstadt, Insa Fuhrmann, Christian Motika, Stephen Mercer, Owen O'Brien and Partha Roop, introduces a new model of concurrent computation called the sequentially constructive (SC) model of computation (MoC). The proposed model is a conservative extension of the synchronous model of computation, which ensures determinacy of computation but imposes too strict constraints on the class of valid programs. The main idea is to take advantage of programming patterns from sequential programming as long as the scheduling that can be inferred from the sequentiality of the program rules out race conditions. As a result, the proposed model accepts a strictly larger class as valid programs.

We would like to thank the authors of the accepted articles for very interesting contributions and the reviewers for valuable comments and suggestions that helped the authors to revise and improve their original submissions.

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